

PROSHAKE 2.0 TUTORIAL

The easiest way to learn the basics of ProShake's organization and operation is to complete the tutorial exercise detailed in this section. This tutorial will take you through nearly all of ProShake's function - entering input data and specifying the desired output, running an analysis, and examining the results. The tutorial is intended to get you up and running with a relatively simple soil profile so that you can understand the basic operation of the program and appreciate its main features; it should only take about 15 minutes to complete. The user's manual provides more detailed explanation of the basic and more advanced features of the program.

ORGANIZATION OF PROSHAKE 2.0

Like its predecessor, ProShake 2.0 is organized using three basic "managers" - the Input Manager, the Solution Manager, and the Output Manager. For most analyses, you will move through these three managers in order, but the program is organized to allow you to bypass the Input Manager and/or the Solution Manager if you want to work with existing files.

GETTING STARTED

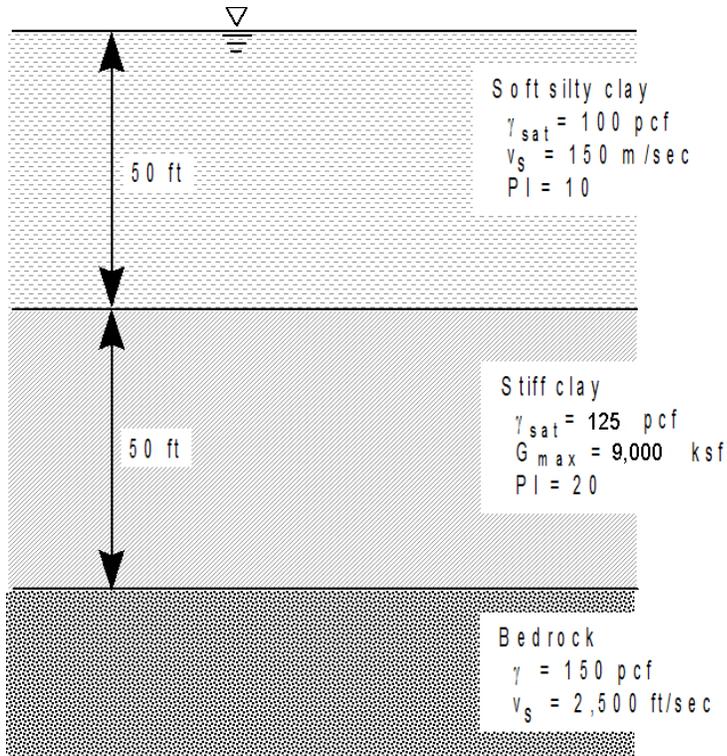
The first step in this tutorial exercise is to start the ProShake 2.0 program. Click on the ProShake 2.0 icon to start the program.

After the splash screen, the first screen ProShake 2.0 displays shows a largely blank screen with a menu bar and ribbon at the top. The menu bar has six headings – (from left to right) File, Edit, View, Tools, Windows, and Help. To the right of those, you will see the three main modules of the program – the Input Manager, Solution Manager, and Output Manager. Below the menu bar, the ribbon contains four groups – (from left to right) Project, Program Options, Utilities, and Help. Within each group are a number of different controls, most of which can also be reached from the menu.

ProShake 2.0 has an extensive help system that operates like most conventional Windows help systems, and can be accessed in two ways. First, clicking on the Help header will allow you to choose between working your way through the contents of the ProShake 2.0 help system and searching for the specific item you are interested in. The second way of accessing the help system is through a context-sensitive feature - simply move the cursor to the field you want information for, then press F1.

SETTING UP AN ANALYSIS

Setting up a ProShake 2.0 analysis involves defining the properties of all soil layers within the profile to be analyzed, specifying the characteristics of the input motion that will be applied to the soil profile, defining the quantities to be computed and displayed, and documenting the input data. Follow the steps in the following sections to set up, run, and view the results of a typical ground response analysis.



The tutorial will set up and solve for the response of the soil profile shown to the left when subjected to a bedrock motion equal to that recorded at Yerba Buena Island in the 1989 Loma Prieta earthquake. The soil profile consists of a 50 ft thick layer of soft silty clay over a 50 ft thick layer of stiff clay underlain by bedrock. The groundwater level is at the ground surface. The input motion is to be applied at the top of bedrock.

The tutorial will take you through the main steps in a typical ProShake analysis - definition of layer properties, specification of input

motion, documentation of input, running the analysis, and documenting the results of the analysis. Each of these steps are described in detail in the following sections. Completion of the tutorial will provide a very good introduction to the structure and operation of ProShake.

DEFINITION OF PROJECT

1. ProShake 2.0 organizes its input and output in terms of "projects." A project can include one or more soil profiles subjected to one or more ground motions. There is no limit to the number of profiles or the number of input motions. Begin the tutorial by clicking on New to define a new project.
2. Type in a short Project Identifier – this is a short phrase that will identify the project to you. It will be written to output files. This identifier should identify the soil profile to you and other potential users - it will be echoed on subsequent screens and in output files.

3. Type your name or initials in the Analyst Name text box.
4. Enter the number of soil profiles that are to be analyzed. You can analyze as many soils profiles as you want, but they will all be subjected to the same suite of input motions that you provide. For this tutorial, specify one profile.
5. Select the type of units you would like to use for your data. You can select U.S. Customary (ft, lbs) or Metric (m, kN). You can switch back and forth if it is convenient for you to enter some data in each format.
6. Add a Project Description. The Project Description text box will increase in size when you click on it so that you can enter a more detailed description of your analysis, assumptions and other information to document for future reference. The text box will shrink back to its initial size (but the data will be retained) when you move the cursor to another field.
7. The Project Date text box should display the current date based on your computer's calendar, so you shouldn't have to do anything with that field.
8. Enter the number of input motions you plan to apply to your soil profile(s). For this tutorial, specify five motions.

DEFINING SOIL PROFILE

Now you are ready to move to the Profiles tab, which should already be highlighted. Across the top of the Profiles tab, you will see a set of buttons with the following labels and functions:

Insert – inserts new soil profile with no data

Duplicate – duplicates current profile as a separate new profile.

Delete – deletes current profile.

Plot – plots data (V_s , G_{max} , density, ...) for current profile once that data has been entered.

Navigation buttons – a series of standard navigation buttons allows movement between profiles.

9. Enter a description of your profile in the Profile Description text box.
10. Enter the number of layers for the analysis. Our profile will use ten 5-ft-thick layers for the soft silty clay and five 10-ft-thick layers for the stiff clay. Including the underlying halfspace, enter 16 layers.

11. Enter the layer number at which the input (object) motion is to be applied. For this analysis, the motion will be applied at the top of the halfspace, so enter 16 here.
12. Enter the depth of the groundwater table. Because ProShake 2.0 performs total stress analyses, the groundwater table depth is not needed for the ground response analysis - rather, it is used when vertical effective stresses need to be computed (e.g., for output of cyclic stress ratio). For this example, enter 0.0.

ENTERING SOIL DATA

Now you are ready to enter input data for the first layer. Move to the Layer Detail tab, which should already be active. Across the top of the Layer Detail tab, you will see a set of buttons with the following labels and functions:

Insert – inserts new soil layer with no data

Duplicate – duplicates current layer as a new layer

Delete – deletes current layer

Plot – plots modulus reduction, damping, and backbone curves for current layer

Copy – copies the current layer, which can then be pasted in a different place

Paste – pastes the copied layer after the active layer

Navigation buttons – a series of standard navigation buttons allows movement between layers

13. Making sure that the tab for Layer 1 is active (it should be displayed in the text box at the center of the row of buttons described in the previous step), enter a material name for Layer 1. This can be any alphanumeric string - for this example, call the first layer Soft Silty Clay.
14. The next step is selection of a soil model. ProShake 2.0 has a series of built-in modulus reduction and damping models extracted from the geotechnical earthquake engineering literature. To see the list of built-in curves, click on the button at the right side of the modulus reduction curve field. For this example, select Darendeli (2001). The Darendeli model describes modulus reduction and damping behavior as a function of plasticity index, overconsolidation ratio (*OCR*), number of loading cycles, and frequency. Enter the following values: *PI* = 10, *OCR* = 1, Number of Cycles = 1, and Frequency = 1 Hz. ProShake 2.0 will compute the modulus reduction and damping curves that correspond to the data you enter. The value of K_0 is used to compute the mean effective stress, which the

Darendeli and Menq models require; a default value of 0.5 is used but any value can be entered. If you use a different soil model that doesn't use all of these variables (e.g., C_u in the case of Darendeli), one or more of the fields in which you just entered data may be grayed out.

15. Then enter the soil data for the first layer – the thickness, unit weight, and either shear wave velocity or low-strain shear modulus. Enter a thickness of 5 ft, a shear wave velocity of 150 m/sec (you'll need to change to metric units to enter that value), and a unit weight of 100 pcf (after changing back to U.S. Customary units). Once the unit weight and V_s are entered, the corresponding G_{max} value will be calculated. When this data has been entered, you will notice a graphical display of the soil profile appear in the Layer Plot tab on the right side of the screen. This plot will adjust itself as more layers are added and the color of each layer will be scaled to its shear wave velocity – this feature can help you detect obvious errors in input data (such as a misplaced decimal point). You can have the color scaled to other variables by selecting another from the Plot Items dropdown list. You can also plot these variables by selecting the Profile Plot tab above the plot. Such plots can also be obtained (with higher quality) by clicking the Plot button at the top of the Profiles tab.
16. Check your modulus reduction and damping curves by clicking on the Plot button at the top of the Layer Detail tab. This will show the modulus reduction and damping curves (modulus reduction scale on left; damping scale on right) corresponding to the data you entered. Below the modulus reduction and damping curves is a plot of the backbone curve, i.e., the stress-strain curve implied by the data you entered. By convention, the modulus reduction and damping curves are plotted with strain on a log scale, which is unconventional for the backbone curve. A linear strain scale can be obtained by unchecking the X-axis log scale checkbox.

Note that the position of the cursor is indicated as the cursor is moved around on both plots. The plots can also be pasted as figures into a Report (a Word file) and as data into a Spreadsheet (an Microsoft® Excel® file). These features are generally available in all plots.

17. Now that you have entered data for the first soil layer, you can go ahead and enter data for the other layers of your profile. You have three main choices for how you do that:
 - You can navigate to each of the layers using the navigation buttons at the top of the Layer Detail tab and enter the required data in each of the fields, just as you did for the first layer. This process is straightforward and necessary when all of your layers have different characteristics.

- If some of your layers have the same, or nearly the same, characteristics, you can speed up the process of populating their data fields by using the Duplicate button. The Duplicate button will add an identical new layer immediately below the active layer – it will, however, move all layers below the new layer down by the thickness of the new layer and will increase the number of layers by one. If you plan to create a profile with 10 identical layers, for example, it can be very efficient to specify a two layer profile, enter the properties of the first layer, and then hit the Duplicate button nine times. That will give you 10 identical layers with the properties you entered plus a half-space layer beneath the lowest soil layer.
- You can also transfer data from one layer to another using the “Copy” and “Paste” buttons or a drag-and-drop feature on the Layer Summary tab. The Layer Summary tab will display the layer properties in tabular form. If you want to assign the properties of Layer *i* to Layer *j*, left-click on Layer *i* and then drag the cursor down to Layer *j* and release the left mouse button – the properties of Layer *j* will then be the same as those of Layer *i*. This can be a very fast way of creating a soil profile when some of the layers have the same properties; the Layer Summary view also helps visualize which layers have data and which don't as the profile is being constructed.

18. Use the third of the above procedures to assign the properties of Layer 1 to Layers 2-10.
19. The 50-ft-thick silty clay layer that has just been defined is underlain by 50 ft of very stiff clay which we will represent using five 10-ft-thick layers. To enter the data for Layer 11, first copy the properties of Layer 10 to Layer 11 by dragging and dropping. Now change the thickness of Layer 11 from 5 ft to 10 ft - click on the thickness cell for Layer 11 and type 10 followed by the Tab key. Using the same procedure, change the Material Name to Stiff Clay, the Unit Weight to 125 pcf, G_{max} to 9,000 ksf, and PI to 20.
20. Now use the drag-and-drop feature to assign the properties of Layer 11 to Layers 12-15.
21. Finally, the properties of the half-space must be specified. Working either on the Summary Data form or on the tab for Layer 16, enter the input properties for bedrock with a unit weight of 150 pcf and shear wave velocity of 2500 psf. Assign the Rock modulus reduction and damping curves to Layer 16.
22. Now we must specify what information is to be computed during the ground response analysis. You can request motion time histories (acceleration, velocity, and displacement), shear stress and shear strain time histories, and response spectra. Note that motion data and response spectra correspond to the top of the layer and stress and strain data correspond to the mid-depth of the layer. For this example, we will compute

motion time histories and response spectra for all layers. To do so, go to Layer 1, check Apply to All Layers and then check Motion Time Histories and Response Spectra. When the Apply to All Layers is checked, any selection/deselection made will apply to all layers.

23. Now that all of the layers are defined and the output specified, check for obvious errors (such as a misplaced decimal point). You have three main options for doing this:

- Look at the Layer Plot in the tall pane at the right side of the window. The colors are scaled to the value of the indicated Plot Item. Cycle through the available plot items and look for unexpectedly different colors.
- Click the Profile Plot tab at the top of the tall pane. This will provide line plots of the same input data.
- Click the Plot button on the Profiles tab. Click through the various plot options to make sure the values are what you intended them to be.

24. Click on the Messages tab on the tall pane at the right side of the window. There you will see depth and stress information for the active layer – it can be handy at times to see this information.

SPECIFICATION OF INPUT MOTION

28. Now the input motions must be specified. Click the Motions tab next to the Profile tab. This will bring up a form that allows you to select an input motion, define its characteristics, view it graphically, and compute various ground motion parameters associated with the motion.
29. You have already specified the use of five motions. Check to see that Motion 1 of 5 is active at the top of the Motions tab, then click on the ellipsis (...) to the right of the field labeled Motion File Name. This will take you to the EQs folder in the ProShake Data Folder where input motions are stored. Click once on the DIAM.EQ input motion file – this will display pertinent characteristics of that input motion without loading it into your input file. You can click once on any file to examine its characteristics before loading it. To load it, either click the Open button in the lower right corner, or double-click on the filename.
30. Move to Motion 2 of 5 and add the ELCENTRO motion, then add TAFT, TOPANGA, and YERBAISL as Motions 3-5. Various plots and common ground motion parameters for the object motion can be obtained by clicking on the buttons at the right side of this form - you should spend a little time playing with these. Note that you can create multiple plots at one time, which will be more useful for spectra than for time histories. You can quickly plot curves for all of the motions by right-clicking anywhere in the Select column of the

table below the plot. Plotting the response spectra for all five motions will show large variability between them. To reduce this variability, go to the Peak Acceleration text box for each motion and enter 0.3 g. Then plot all of the response spectra again to confirm that the peak accelerations (or zero-period spectral accelerations) are all 0.3 g.

31. Select Apply as Outcrop Motion and Animation. This will instruct ProShake 2.0 to compute the response at the locations necessary to produce an animated view of ground response that can be viewed in the Output Manager.
32. The soil profile and input motion have now been completely characterized. Save the project file with the name "Tutorial.xlsx." This file, which is in Excel format but can be opened on computers that don't have Excel installed, will contain all of the input data and will also hold all of the output data when the analysis and its interpretation have been completed.

CHECK YOUR INPUT

33. Click on the Messages tab on the tall pane at the right side of the window, then on Validate at the bottom of that tab. The program will perform a quick check of your input data for missing or erroneous data and notify you if something is amiss.

RUNNING THE ANALYSIS

34. To run the ProShake 2.0 analysis, select the Solution Manager. Click the Analyze button in the lower right portion of the form. The program will then ask you to specify a Report file – the report is a Microsoft® Word®-formatted document that will contain a record of your input data and provide a repository for plots that you choose to copy to it. The default filename will be the same as that of your project name, but with the .docx extension.
35. The program will run all of the motions and provide an indication of its progress (with elapsed times for individual motions, in the Messages pane).

EXAMINING THE RESULTS OF THE ANALYSIS

To look at the results of your analysis, select the Output Manager. You will see a series of tabs labeled Solution Convergence, Ground Motion, Stress and Strain, Depth Plots, Response Spectra, Transfer Function, and Animation. The best way to see how ProShake 2.0 displays the results of the analyses is just to play around with the plots – they are essentially self-explanatory. The following few tips can be helpful, though:

- The process of examining the output can be sped up considerably by filtering capabilities that have been built into ProShake 2.0. For example, click on the

Response Spectra tab – you will see that you can choose to plot response spectra for the tops of all 16 layers for all 5 motions, which is a total of 80 curves.

- If you want to see all 80 plots, right-click anywhere in the Select column and choose Select All. Then click on the Plot button in the lower right corner.
 - It is more likely that you would want to see only the motions from a single layer. You can then filter the output to select only the plots you would like to see. Start by moving the cursor to a cell showing the layer number you are interested in, and then right-clicking in that element. Click again to filter only the motions for that layer number and select the one(s) you want. You can right-click in the Select column to select all of the motions with a single mouse click.
 - To focus on a particular portion of a graph, hold the CTRL key down and draw a rectangle with the left mouse button – the area of the rectangle will be scaled to fill the plot area when you release the left mouse button. Holding both the CTRL and SHIFT keys down and moving the mouse will allow you to zoom in or out.
 - Many variables can take on a wide range of values. Many of the plot forms offer check boxes to change the axes from linear to logarithmic scales.
 - Some variables are assumed to be constant within each soil layer, some vary smoothly over the height of a profile, and some vary linearly over depth. Many of the plots offer the ability to change the nature of a plot from Step Chart (values are constant within a layer) to Spline Fit (values vary smoothly). Selecting neither defaults to linearly interpolated values.
 - To change the characteristics of a graph, double-click on it. This will take you to the graph control where you can change axis scales, symbols, and other features of the graph.
 - Any plot can be copied to the ProShake Report by clicking the Copy to Report button, and the data underlying any plot can be exported to the output (Excel) file by clicking the Copy to Excel button. The data and the corresponding Excelbased chart will be found on the Exported Data and Exported Charts worksheet respectively, in the project Excel file.
36. On the Ground Motion tab, select Layer 1 for Motion 1 in Profile 1 and plot the time history. The time history of acceleration will be plotted by default, but time histories of velocity, displacement, and Husid parameter can also be plotted. The units of the variables can be

changed on the fly, and any motion can be saved in ProShake format using the Save as Motion button.

37. On the Depth Plots tab, select all motions and click the Plot button. Depth plots of peak acceleration will be plotted by default, but there are 13 other variables that can be plotted. Go ahead and select different plot parameters to see how they all vary from motion to motion for the tutorial profile. The Log Statistics check box will add curves showing the median (50th percentile) and 16th and 84th percentile values (these can be seen more clearly by checking the Hide Selected checkbox). Note that both scales can be made logarithmic (useful for parameters like shear modulus that can vary tremendously), and the plots can use linear, step, or spline interpolation between data points.
38. On the Response Spectra tab, select all motions and plot the response spectra. Again, plots of velocity and displacement spectra are available, and all can be plotted vs. period or frequency. Log scales can be specified, as can logarithmic statistics.
39. On the Transfer Function tab, select all motions and plot the transfer functions. The amplitude of the transfer function is plotted as the default, but the phase angle (wrapped at $\pm \pi$ radians) can also be plotted. If desired, the real and imaginary parts of the transfer function can be plotted.
40. Click on the Animation tab. Click on one of the displayed animation cases, then click the Plot button. You will see an animation of the displacement profile for that case. The animations will also be saved as files that can be inserted into Microsoft® PowerPoint® or other presentations.
41. Take a look at the ProShake Report by clicking on Report in the ribbon across the top of the main form. You can also look at the input and output data by clicking on the Spreadsheet button.

You have now completed a ProShake 2.0 analysis. To see how easy it is to work with ProShake 2.0, go back to the Input Manager and make some changes to your input file. As you will see, making the changes, running the analysis again, and viewing the results can all be accomplished quickly and easily.